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Snowed in: the effects of inclement weather closures on AP exam performance

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SNOWED IN:
THE EFFECTS OF INCLEMENT WEATHER CLOSURES ON AP EXAM PERFORMANCE

by

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"The snow doesn't give a soft white damn whom it touches." – E.E. Cummings

DEDICATION

I would like to dedicate this work to my dad, my original teacher, and to all of the teachers who have gone above and beyond since.

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I like to complain. A lot. And there are certain people who deserve to be acknowledged for hearing the bulk of it. First, I need to thank my advisor, Professor Katherine Einstein, who tolerated my constant emails and meeting requests. And thank you to my research assistant Sara Mack, who called and emailed hundreds of school districts for this project.

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ABSTRACT

This thesis examines the impacts of inclement weather days on AP exam scores in public schools, specifically low socioeconomic districts, and the assessment of their current closure procedures. By investigating the potential disruption in scores by inclement weather days, I can create a new dataset in analyzing a field that has yet to be studied through this lens, in addition to advising future policy for district superintendents and state government officials. The areas studied include Massachusetts and Georgia, representing states that are properly prepared for inclement weather closures and are under-prepared for inclement weather, respectively.

I use two research methods to fully understand the quantitative and qualitative effects of inclement weather closures. The first is a quantitative analysis of district-level data on inclement weather days and AP exam scores over the past five years. To accomplish this, I contacted public-school districts in the two states involved in the case study to get raw data on school closures and combine this with already available datasets on AP exam score performance. The second is a qualitative account of inclement weather days from teachers and superintendents from districts across both states to establish their opinions regarding school closures and investigate the decision-making process in canceling school. In this qualitative assessment, I observe the roles that socioeconomic

status and public transportation, among other factors, play in cancelations.

This thesis seeks to challenge the argument proposed by previous research that snow days have no effect on test performance. Previously, this was measured by looking at state-wide exams. By using AP exams as a performance measure instead, a more direct impact on exam scores is expected due to the immovable testing dates and content-specific nature of the exams. Policy recommendations are given to accommodate the negative relationship between closures and test scores, given socioeconomic status.

PREFACE

When I started this paper, COVID-19 had yet to exist. Finishing this paper, we are in what might not even be the peak for the U.S. Over the course of the past few weeks, articles have been circulating regarding the state of education in the wake of the pandemic. Children who rely on school lunches aren't eating. Teachers and students alike are struggling with the transition to online learning. Inequities in internet access are being exposed. Standardized tests and the universities that rely on them for admissions decisions are scrambling to adapt. But these aren't new issues.

Every year, millions are plagued by these problems, as extreme weather forces schools to close for a day or more. For every snow day, there is one more student not eating lunch, not passing an exam, and not learning the material while their peers take online lessons. These effects are multiplied over the days, sometimes lasting over a week, that school is canceled for weather. In the case of severe emergencies that can destroy towns, like wildfires, tornadoes, or hurricanes, no accommodations are made for those who have just lost everything. They are expected to sit down and take their AP exams at the same time as everyone else in the country, or risk college admissions prospects or chances for gaining college credit. This could be the difference for some in saving thousands of dollars.

I am not saying that schools should never close for weather, nor am I advocating my findings in this paper as the final solution. But I am imploring you, the reader, to take these considerations into mind when we have gotten through this pandemic and return to life as normal. These issues are not cured with a vaccine.

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LIST OF ABBREVIATIONS

AP	Advanced Placement
ED	Extended [School] Day
EY	Extended [School] Year
GPA	Grade Point Average
MCAS	Massachusetts Comprehensive Assessment System
MSPAP	Maryland State Performance Assessment Program
PTA	Parent Teacher Association
SAT	Scholastic Aptitude Test
SES	Socioeconomic Status

CHAPTER ONE

Introduction

Since the days of standardized tests began to become the norm under No Child Left Behind in the early 2000s, measurements of education have rested on state-standardized tests and the many performance exams of The College Board. Disparities in education have been highlighted under such programs, as poorer and largely majority minority districts fail to produce “acceptable” numbers. Many of these issues arise from a lack of resources due to underfunding and a general blind spot towards the needs of these districts and pupils in the education system. But what if these schools were also being setback by something out of anyone’s control? As extreme weather becomes more prevalent due to global warming, inclement weather closures from snow and tropical storms are threatening schools with closures throughout the school year.

School districts are uniquely paralyzed by snow storms as they have to make decisions with the safety of their pupils as their primary consideration. This is especially true when the district is large or urban, as coordinating bus systems becomes a hefty feat. As snow and inclement weather days accumulate throughout the year, districts have to make tough calls weighing the safety of their students against the potential repercussions of lost class time. Furthermore, according to a recent study, the average American student is already absent more than two weeks out of every school year (Goodman, 2014), so the addition of inclement weather days only contributes to time spent outside of the classroom, reducing learning time.

In the high-stakes world of standardized testing, these absences can be detrimental

to school districts. As mentioned, standardized test performance has become a performance metric that can have profound effects on school districts. These can either be a source of pride or demerit on a school or school district's records as it is often used as a proxy for the quality of the public education received by their students. The common focus on academic performance is usually centered on state standardized tests, like the Massachusetts Comprehensive Assessment System (MCAS), or national standardized tests like the ACT or SAT, because these allow districts to be compared to one another and may serve as guidance for the distribution of resources. A monetary penalization for poor test performance can lead to layoffs, less employee benefits, and in cases of consistent underperformance, school closures. For students, low scores can bar them from receiving college credit and impact their college admissions (Geiser and Santelices, 2004).

Unfortunately, the effects of these disruptions do not stay within the boundaries of the classroom. When school is closed, for some students, that does not simply mean that classes are canceled. For those that rely on free and reduced school lunches as a consistent daily meal, cancelations can mean going a day without food. Some may be going home to unsafe environments, or to no supervision at all, as working parents cannot afford to stay home to watch their children. Closing school for the day means much more than just academic scores.

New research has progressed to look at the impacts of snow on regular activities. Many studies have demonstrated the effects that extreme weather conditions have on people's everyday lives, including ramifications for workers with hourly wage jobs.

Some have even extended this impact to apply to school performance on standardized tests. However, in reading these studies, it is found that in the realm of standardized tests, all of them are either offered year-round or are able to have the testing date adjusted in the case of inclement weather impacting school. This can occur up to only days before the test, should the school district petition for the adjustment. I found myself questioning whether the impact would be the same in the case of an immovable test, one where students across the country would be sitting down and taking that exam at the same time no matter the circumstances prior to the test day. The only test of this nature is the Advanced Placement (AP) exam, which generally takes place in early to mid-May, *after* the bulk of inclement weather delays. With these considerations in mind, my research aims to answer the question: What effect do inclement weather days have on school district performance on Advanced Placement exams? Accordingly, are these effects amplified or changed by the socioeconomic status of a school district?

Although prior research has indicated that there is minimal to no effect on snow and inclement weather days on standardized test performance, I hypothesize that the rigidly set dates of the AP exams combined with their subject-specific nature will set them apart from other tests and test performance with be more negatively impacted by weather-related school closures. Within this investigation, I also seek to understand if there is a statistically greater negative relationship when looking at the effect of school closures on the exam performance of students in poorer districts relative to wealthier districts.

Adding to the quantitative approach in my methodology, the use of interviews

serves as a qualitative supplement to this analysis. Through a series of interview with superintendents and teachers from various school districts, I aim to explain the relationship between school closures/disruptions and academic performance, as well as advise policy proposals to amend any negative relationships.

This paper provides a nuanced examination of the effect of inclement weather closures on standardized testing by focusing on a more consistent and susceptible constant variable of the AP exam. In doing this, I am able to supply evidence of the impact on instructional time by quantifying these disruptions through fixed effects regression models which show a statistically significant negative relationship between inclement weather closures and student achievement in some areas. Adding to this are the instrumental variable models which weigh the effects of socioeconomic status on this negative relationship, exploiting the greater harm that is done to lower socioeconomic districts by these disruptions.

Two distinct contributions to the literature are provided by this paper. First, it adds additional analyses that have been missing from prior work on the study of academic disruptions. My focus on subgroup regressions on the socioeconomic status of districts as well as my comparison of states of varying environments and procedures add new variation to the field. Goodman (2014), Marcotte (2007), Marcotte and Hemelt (2008), and Hansen (2013) all look at exceptionally snow-inclined regions such as Massachusetts, Maryland, and Colorado. In examining both a region like this (Massachusetts) and an area prone to less snow and more tropical storms (Georgia), I am able to expand the analysis of unplanned disruptions in the school day as well as

contribute a more advised recommendation as to how to accommodate for such disruptions by weighing both states respective procedures.

The paper's second contribution is the supplemental interviews that further advise policy recommendations and explanations for the magnitude of a closure. Current recommendations generally point to increased self-pacing learning technologies (Goodman, 2014). However, with the narratives provided by teachers and superintendents, it has become clear that there is no one standard solution for all districts. Recommendations from superintendents and teachers varied by socioeconomic status and structure of the district they represent. Make-up policies including online learning days, extended school years or days, and built-in weather days were all proposed and described as suitable for only certain types of districts. This variety in recommendations, or supplement of interviews at all, is something that the current literature is missing entirely.

Literature Review

Though limited, the literature on inclement weather focuses on the effects as measured by state standardized test performance or the general impact that school absences have on student learning. It should be noted that it is not only the physical absence of the student from school that effects test performance, but also the disruption that these cancellations cause. Disruptions indicate a ripple-effect of sorts that have additional influence on test performance, including extenuating factors like disruption of class momentum or flow, and the inconsistent provision of meals to students. Should my hypothesis be correct, each day of missed in-person learning due to inclement weather

closures could have profound effects on both students and school districts as a whole. The current literature outlines effects of these disruptions on student academic achievement through the use of standardized test performance in addition to emphasizing the importance of physical classroom learning.

Inclement Weather and Standardized Testing

Focusing on the Massachusetts Comprehensive Assessment System (MCAS), Joshua Goodman analyzes the test results of this state-standardized test across several years and discovers that the impact of lost instructional time depends on the particular *form* of time lost. He finds that schools and teachers are prepared to deal with disruptions caused by snow days, but they are unprepared to handle frequent disruptions caused by poor attendance. Estimates suggest that absences explain 8-20% of the achievement gap between poor and nonpoor students, for example (Goodman, 2014). Goodman, it is important to note, does not disagree that missing school causes a disruption in education, however he finds that individual absences in addition to school-wide closings cause a more significant disruption.

Some researchers, however, find the opposite. One such study (Marcotte, 2007) looks at student performance on statewide assessments in Maryland, the MSPAP, and finds the number of students performing to standard on state reading and math exams is nearly three percent lower in years with an average of five snow days, as compared to the years that had no snow days. This research uses general snow accumulation in districts within Maryland rather than the number of inclement weather closures. It should also be

noted when comparing these studies that the MCAS may be delayed up to a week should the school petition for a date change due to snow days, while the MSPAP is immovable. Additionally, similar conclusions were drawn about Maryland, as well as Colorado, when finding that most weather-related cancellations are made up at the end of the school years, allowing a relatively large fluctuation in instructional days within school districts prior to test administration (Hansen, 2013).

Student Absences

The effects of missing school due to inclement weather closures have been relatively under researched, and not much more is found within the discourse on the effects of missing school as an individual student. This seems counterintuitive to the statistics, given that the American student is absent at an alarming rate of two weeks out of every school year (Snyder and Dillow, 2014) and attendance is used to support local and state administrative data sets that comprise much of today's education research (Goodman, 2014). The majority of this research also uses state standardized testing and looks at the effects within an elementary school rather than at a high school- or district-wide level, where AP testing would be conducted. While there is no current research investigating inequality in which schools assign inclement weather days, at an individual level, poor students are absent three more days on average than nonpoor students (Goodman, 2014).

Generally, student absences can impede the public aspects of the learning process as teachers divide their time between students who have and students who have not

missed the previous day's lessons (Goodman, 2014). Though Lazear (2001), who lays out the model of instruction in which coordination of students in the central challenge, emphasizes behavioral disruptions as the main source of congestion, they are not the only source. Predictions of that model that involve optimal class size and the effects of changing class size can interchange "student behavior" and "student attendance" (Goodman, 2014).

Outside of the general disruption of class flow and structure, individual absences can be damaging to a student's education when measured through GPA and standardized testing. Consistently, it has been found that there is a positive and statistically significant relationship between student attendance and academic achievement[1]. When forming a quasi-experimental design to estimate the causal impact of attendance on multiple measures of achievement, Gottfried (2010) found that the coefficients on the number of days present indicated positive, significant relationships between individual attendance and student-level achievement; students who attended school had higher GPAs. This was true even when controlling for student and neighborhood characteristics, and school, grade, and year fixed effects (Gottfried, 2010).

Extended School Year

Regardless of whether the absences are driven by inclement weather or by personal/social factors, the most common proposed solution to student absence is to extend the school year or generally increase time spent in the classroom. Charter schools

[1] This is generally found at the elementary and middle school level.

are often used as models of success for extended school years/days (Carlsson et al., 2012) (Hoxby and Murarka, 2009). School year length can be a contentious topic, and there has been much debate about the effects of increasing or decreasing the number of days children spend in school, a synonym for aggregate learning time. Many scholars have attempted to quantify and explore the effect of a lengthened school year on academic and personal preference. In a meta-review of research, (Patall et al., 2010) find that, "extending school time can be an effective means to support student learning." Notably, the paper also points out that increasing mobility of the American family in the 20th century led to a need for some standardization in the length and curriculum of a school year. It was only in the 1960s that today's standard 180-day school year calendar came into being for the majority of the states (Patall et al., 2010).

One case study exemplifying the research on an extended school year is about the public charter school Robert Treat Academy, of Newark, New Jersey. Robert Treat had the highest test scores out of all urban New Jersey Public Schools in 208 (Durnado, 2008). While the average school year is 180 days long, it runs anywhere between 205 and 210 at Robert Treat. Theoretically, a lengthened school year would give teachers more time to cover material at a slower pace, allowing for a more in-depth instruction and a higher quality education. Pattall et al. expands on this, explaining that, "proponents of EY (an extended school year) and ED (an extended school day) argue that additional time is expected to promote learning and achievement via increased time on task, broader and deeper coverage of the curriculum, more opportunities for experiential learning, and deepened adult-child relationships" (Pattal et al. 405-406).

These results continue outside of a case study basis, as Hansen (2013) finds that both the response probabilities and the implied effect on latent test scores yield evidence that increased instructional days raise student performance. This suggests that extending the school year can be a method of increasing student performance, as they found that with five additional days of instruction, test scores would increase by as much as 0.15 standard deviations (Hansen, 2013).

However, specifically looking at Massachusetts, a case study in my research, the state has not benefited from an extended school year. 26 schools across Massachusetts, encompassing grades 5th through 8th, participated in the extended learning program in the state. After adding 300 hours of instructional time a year to a subset of schools, there were no measurable impacts on student achievement as measured by standardized tests like the MCAS (Abt Associates Inc., 2012). Despite not having academic success, there were improvements elsewhere. Teachers reported having sufficient time in the day to complete all of their work and in the first and second years of implementation, these test schools served a statistically significantly greater proportion of minority students than estimated in the absence of the extended year (Abt Associates Inc., 2012).

Socioeconomic Status

The latter of these achievements is one that opens up a subfield of research within the study of extended school years: the impact of additional school hours on low socioeconomic districts. It has become apparent that time physically spent in the classroom is paramount for low SES districts looking to close the achievement gap. Prior

research on student absenteeism suggests that attendance for all students, but especially economically disadvantaged students in low-income districts, is contributing to a widening education gap. Looking at the effects in younger children, the effects of school attendance and physical classroom instruction on cognitive development are stronger for lower SES children. Socioeconomically disadvantaged students who maintain high rates of attendance gain more literacy skills than higher SES peers (Ready, 2010).

Furthermore, it is not only time for students spent in the classroom that is essential, but also for teachers. One study looked at teacher absences in a large urban school district and found that for every ten days of teacher absence, mathematics achievement in students decreased by 3.2% of a standard deviation (Miller, Murnane, and Willett, 2008). These teachers in low SES districts are also those most likely to spend a majority of their instructional time "teaching to the test." Low SES districts send more messages to their teachers about the importance of test-curriculum alignment than higher SES districts, and teachers then design their classroom curriculum with this alignment in mind (Herman and Golan, 1990). Combining the importance of low SES students physically attending class with the almost constant test preparation time in class makes these low SES districts even more sensitive to the effects of missing school due to inclement weather closures.

In one study that looks at Baltimore school children, they find that during the summer, upper SES children's skills continue to advance while lower SES children's gains, on average, are flat. During the school year, however, their gains are comparable (Alexander, et al., 2001). Researchers attribute this discrepancy to the out-of-school

environment of these children, primarily influences situated in the home and community. Alexander, et al., recommends policy implications of the seasonality of learning, primarily including calendar reforms and summer school, to support disadvantaged children's learning year-round and offset the damaging academic downtime (Alexander, et al., 2001).

The economic cost of extending the school year or school day is something that also cannot be ignored. Although low SES schools may be the ones who could benefit the most from more instructional time, they may be unable to afford to do so. Although Hansen (2013) discusses the benefits of extending the school year, he adds that this doesn't justify all schools doing so. This, in part, is because the costs of lengthening the school year are not homogenous across districts due to elements like air conditioning, teacher salaries, and transportation, among other costs. Additionally, locations where it is expensive to lengthen their school year might optimally take advantage of other policy interventions, such as reducing the pupil-teacher ratio (Hansen, 2013).

Unsurprisingly, many of the proposals for closing this achievement gap come with extreme monetary measures. The most common is to simply increase school funding. While this is ideal, and has been proven to close the achievement gap in some areas when low SES districts increase spending by $700 per pupil (Lafortune, Rothstein, and Schanzenbach, 2016), this is simply not a reality that all districts can live in. Other extreme measures have come in the wake of extreme weather events, such as the policies taken up in New Orleans after Hurricane Katrina. Transferring to an intensive market-based system, New Orleans school districts fired all teachers, replaced local school board

control with state control, eliminated neighborhood-based school determination, and ended teacher collective bargaining and tenure. These reforms attracted additional funding and appear to have reduced most achievement gaps by race and income, though only slightly in terms of standardized testing (Harris and Larsen, 2019). Though effective in the case of New Orleans, these measures are extreme and unlikely to be taken up by most school districts.

As alternate solutions for missed school time are proposed, there are a few that are left out of common discourse. In the case of an inclement weather day, it is becoming more common for districts to make-up the day by sending students home with assignments and lectures via handout or the internet. This was the case in Massachusetts up until the 2019/2020 school year, as the Massachusetts Department of Education canceled Blizzard Bags run through the Alternative Structured Learning Days program, which assigned work during snow days or other school closures in order to count them as days of school for purposes of meeting legal requirements, as schools are required to meet the mandated 180 days in Massachusetts. Similar programs are being implemented in Pennsylvania through the recent 2019 “ban” on snow days by Governor Tom Wolf, which allows for schools to opt into a program where instead of making up the school day during the calendar year, an alternative lesson is planned instead.

With programs like these come the issue of internet access, as the majority of alternative learning days for high school students are in the form of a live online video lecture or pre-recorded PowerPoint, which requires internet or computer access. Although the racial gap in internet access within public schools is closing (The Once Huge Racial

Gap in Internet Access at Public Schools Has Nearly Disappeared, 2005), internet access at home continues to put low SES students at a disadvantage. According to the US Department of Housing and Urban Development (HUD), almost 30% of households making under $50,000 do not have a high-speed internet connection. Low-income households have lower rates of internet access at home compared with higher-income groups. Connectivity rates are particularly low among HUD-assisted renter households, who are also more likely to depend exclusively on smartphones and other handheld devices to access the Internet in the home. Affordability is the main constraint listed by these households for adopting in-home broadband access. 80% of respondents to the 2015-2016 ConnectHome baseline survey who lacked internet access at home cited Internet costs as one reason why they lacked in-home Internet access, and 37% cited device costs ("Digital Inequality and Low-Income Households"). Should an alternative school day involve the internet, problems may arise for students who are already statistically more likely to be behind.

Also commonly left out from this conversation on school attendance and inclement weather closures is the topic of transportation. Transportation is the main factor discussed in most inclement weather closure policies, comprising both student and staff transportation to school. Different forms of transportation are needed for varying regions based on their urbanicity. While more urban school districts may rely on public transportation to get to school, more suburban or rural districts may rely on cars or longer commutes to get to their schools. Because of this, the distance to school and the type of transportation taken is considered when crafting snow day policy, creating the potential

for more problems.

Current research focuses on urban area and how urban education systems around the country have implemented school choice policies aimed at expanding low-income students' access to high-quality schools. However, many are quick to point out that true access to choose relies on school- or parent-provided transportation. In a report focusing on Denver, Detroit, New Orleans, New York City, and Washington, D.C., it is found that these cities vary widely in terms of providing publicly-funded transportation for students, concluding that in many of these regions' transportation is becoming a barrier to equitable access to high-quality education in urban areas (Blagg and Chingos, 2017). For distance to school, the story is similar, as school commute time is strongly inversely related to time spent sleeping, and negatively related to academic performance (Voulgaris et al., 2017).

Standardized tests as a whole expose the gaps and inequality in the education system, as the most commonly accepted measure of student performance indicates that minority and low-income students are the most behind. African American students currently score lower than their European American peers on vocabulary, reading, and mathematics tests; on some tests the typical American black child scores below more than 85% of white students (Jencks and Phillips, 1998). If an effort was made to close this testing gap, it is hypothesized that a substantial change in racial inequality in educational attainment and earnings (Jencks and Phillips, 1998) in addition to a reduced economic inequality could occur (Jencks, 1972).

Specifically looking at high school-level standardized tests, this gap in student

achievement is demonstrated through SAT scores and GPA. For the SAT, African-American and Hispanic students perform substantially lower than white and Asian students, eventually affecting things like college acceptances and job mobility in the future (Schmidt and Camara, 1999) (Buchmann et al., 2010). Differences in SES are also examined through these measures within and across ethnic and racial groups, and account for a large portion of the group differences found across these educational measures and outcomes (Schmidt and Camara, 1999). SES can also be an indicator for college performance, using SAT and high school rank to predict freshman grade-point average, with lower levels of SES associated with lower performance (Wright and Bean, 1974). Even more, failure to pass standardized tests has a negative mental health impact on those students labeled "at risk." Common themes described by those students failing state-mandated testing include increased stress, shame, shock, and lack of desire to pursue subjects they are passionate about (Kearns, 2011). Students maintained that although they may feel successful in school, failure to meet the state's standards degrades their mental states and self-esteem. While policies are created, like standardized testing, to accommodate these children most at risk, they appear to be further emphasizing their shortcomings rather than helping them to eventually succeed (Kearns, 2011).

Whether it be through transportation, internet access, or standardized test performance, it is clear that students of low SES are set up to fail in the education system. Inclement weather days and any additional disruptions of this sort can only further exacerbate the inequalities that exist within this system. Issues created by these disruptions are expected to be disproportionately felt in places where these challenges are

the most severe. In quantifying the damage of such disruptions and creating plans for combating potential negative effects, this can empower poorer districts to persevere in a system that seems set against them.

CHAPTER TWO

Methods

State Case Studies

Although a select number of researchers have focused on the effect of inclement weather days on state administered standardized testing performance, this research focuses more specifically on the effect of inclement weather days on AP exam scores for two case studies: Massachusetts Public School Districts and Georgia Public School Districts. By looking at a northern school district and a southern school district, I am able to both compare levels of preparedness between the states for inclement weather closure as well as examine the impacts that different types of inclement weather play in influencing closure policy and overall exam performance. Though both regions experience delays due to snow or ice, southern coastal schools, like Georgia, are more likely to experience additional prolonged periods of closure due to hurricanes or tropical storms. The decision to focus on Massachusetts and Georgia is also aided by the fact that both state's Department of Education publishes AP exam performance by subject, district, and year online for the public. Additional states were also considered for this research, but unfortunately were unable to be studied, as both their Department of Education and the College Board, the owner of the AP exam, would not release district breakdowns of the AP exam results. Using the AP exam is a necessary divergence from prior research, as it allows for a more consistent and disruption-sensitive measure of academic performance due to its immovable date and subject-specific nature.

Inclement Weather Policies and Procedures

While there is no uniform state-wide inclement weather policy for either Massachusetts or Georgia, their instructional day requirements influence the ways that both states choose to make up inclement weather closures, if at all. Their policies are as follows:

Massachusetts -

"Under the Massachusetts Student Learning Time regulations, school committees are required to schedule a school year that includes at least 185 days at each school, and are required to operate the schools for at least 180 school days in a school year. In addition, schools must ensure that students are scheduled to receive a minimum of 900 hours of structured learning time per school year for elementary school students and a minimum of 990 hours of structured learning time per school year for secondary school students…

All days lost to health, weather, or safety emergencies between the first day of the school year and March 31 must be made up by rescheduling full school days to ensure a 180-day school year…

Making up missed days can be done in several ways. School districts may decide to take one or more of these actions: cancel or shorten the February or April vacation periods, convert scheduled professional development days into school days for students, hold school days on Saturday, keep school open on Good Friday, or add days later in June beyond the originally scheduled last day of school" (Massachusetts Department of Education).

Georgia-

"State law requires that students are in school 180 days or its equivalent. Each year, school districts are given four "emergency days" they can use for a variety of purposes.

State law authorizes the State Board of Education to empower local boards of education to depart from the strict interpretation of the terms "school year" and "school day" when the Governor proclaims a state of emergency or when there is an emergency that continued operation of public schools to be impractical or impossible" (Barge, 2014).

In both policies there are important factors to note. First, in Massachusetts, schools anticipate that at least five days may be lost each year to weather emergencies with a 185-day schedule, mandating only 180 of those. Some schools may still choose to make up those optional days, and the majority of districts add up to five days onto the end of the school calendar year. For cases of extreme amounts of inclement weather days during the school year, however, some schools make-up the days during the school year, before the AP exam is proctored.

In Georgia, there is a similar flexibility, with the allotment of four emergency days for extreme weather or safety issues. However, the state school superintendent in 2014 passed a resolution allowing local school districts the flexibility to determine if school days missed to inclement weather must be made up. Here, schools that choose to still make-up inclement weather closures generally do so during the school year, before

the AP exam. It is also important to note the types of inclement weather closures that Georgia has. The most common form of inclement weather closure in the state is due to Hurricanes, which trigger a state of emergency for the area, a less likely occurrence for snow in Massachusetts. This means that the most common form of inclement weather closures in Georgia are automatically waived under this allowance, meaning they do not have to make them up at all.

AP Exam

The AP exam was chosen in place of a state standardized test or the SAT, as is common in the field, for a number of reasons. First, the AP exam, compared to state standardized tests, is immovable and only occurs once per year. Students do have the opportunity to take an alternative make-up exam during the final two days of testing if extenuating circumstances prevented them from sitting for the initial exam, but this would merely give students a maximum of ten extra days of study time (eight school days), which would not necessarily comprise time in a classroom learning missed material (College Board). Additionally, all schools regardless of their public or private status can take AP exams, while the state standardized test is only administered to public schools and some private schools whose tuition is publicly funded (Massachusetts Department of Elementary and Secondary Education, 2016).

The content specific nature of the exam is another factor in the selection of the AP over other exams. Currently, there are 38 different AP subjects offered, making the material specific to the subject, unlike the SAT and state tests which cover three, broader

subjects, falling under the basic categories of "Math", "Reading," and "Writing." Due to the specificity of the exam, a lesser emphasis on "strategy" when taking the exam, and the use of class time as the primary means of studying, this makes the AP exam a stronger measure for academic performance than the SAT, which is generally studied for outside of school, with some students opting for additional study guides, tutors, or classes. Furthermore, it has been found that the SAT has a relatively poor predictive power compared with curriculum-based achievements tests, such as the AP exam, in predicting first-year students' success in college (Geiser and Santelices, 2006). Even more, the AP exam, which requires the greatest depth of subject knowledge, exhibited an even greater predictive advantage that the SAT Subject Tests. Participation in these exams bore no relation to this success, but students who took and scored well on the AP exams tended to be very successful: second only to high school grades in predicting student performance (Geiser and Santelices, 2006) (Atkinson and Geiser, 2009).

Generally, AP exams range from 1 to 5, with a 1 being the lowest score possible and a 5 being the highest. Most colleges only grant credit for or acknowledge in their admissions process AP scores of 3 or higher (The College Board, 2019). I therefore chose to evaluate as my dependent variable more specifically the percentage of students who received a 3 or above on their AP exams.

Data Collection

To effectively answer my research question, I combine three sources of data. I first collected panel data on a district's inclement weather days by reaching out to 275

school districts in Massachusetts and 154 in Georgia that reported AP score data for the 2018-2019 school year, either through a phone call, an email, or an online contact form. These school districts are schools that have ten or more students enrolled and are deemed 'public school districts' by the state Department of Education. I then combined this dataset with the published AP exam scores and the percentage of economically disadvantaged students in each district. The latter served as a secondary examination within my qualitative analysis, with districts broken down into three groups based on what I am calling Level of Disadvantage:

Massachusetts[2] -

Lowest tercile: ≤ 13.1% of students are economically disadvantaged

Median: 13.2% ≥ x ≥ 36.9% of students are economically disadvantaged

Upper tercile: ≥ 37% of students are economically disadvantaged

Georgia[3] -

Lowest tercile: ≤ 27% of students are economically disadvantaged

Median: 28% ≥ x ≥ 46% of students are economically disadvantaged

Upper tercile: ≥ 47% of students are economically disadvantaged

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[2] Massachusetts changed its measure of "economically disadvantaged" students after the 2013/14 school year in accordance to the USDA Community Eligibility Program (CEP). The measure is now based on a student's participation in one or more of the following state-administered programs: the Supplemental Nutrition Assistance Program (SNAP); the Transitional Assistance for Families with Dependent Children (TAFDC); the Department of Children and Families' (DCF) foster care program; and MassHealth (Medicaid) (Massachusetts Department of Education).

[3] Georgia changes its measure of "economically disadvantaged" students after the 2013/14 school year in accordance to the USA CEP. Directly certified students now fall into at least one of the following categories: Lives in a family unit receiving SNAP food stamp benefits, lives in a family unit receiving Temporary Assistance for Needy Families (TANF) benefits, or identified as homeless, unaccompanied youth, foster, or migrant (Georgia Department of Education)

A similar method was used for my quantitative analysis, but the grouping was only sorted into two levels, Low Level of Disadvantage and High Level of Disadvantage, with the determining point being the median percentage of economically disadvantage students per district for each state. In Georgia, that point was 33.5%, and in Massachusetts, that point was 18.9%.

Because my research question strives to understand if there is a statistically significant relationship between the number of days students spend in the classroom prior to AP exams and subsequent AP exam scores, I omitted all observations (districts) for which AP scores were reported but no AP courses were offered by high schools in those districts. This data would represent students who sat for the exams without having taken an AP course, and will be disregarded for the purpose of this research. Additionally, I excluded two online school districts listed in the dataset for Massachusetts, as this would not be impacted by snow days.

I selected a five-year period from the 2014/15 through the 2018/19 school years because the majority of districts only consistently reported inclement weather data dating back five school years. For more school districts, this information was only partially complete, and so to complete the dataset I relied on online local news reports of inclement weather school district closures. These reports were consistent, and thus reliable, to fill in the gaps in the districts' personal reporting. Importantly, almost all of the reported inclement weather days occurred during September, January, February, or early March. Because AP exams are administered in the first two weeks of May, I can be

certain that all of the missed time due to inclement weather school cancellations would have occurred *before* the testing dates.

Estimating the Effects

In my study, I set out to compare the effect of snow days on one subset of my dependent variable: the percentage of 3-5 (passing) scores received on all types of AP exams. To analyze this, I ran a fixed effects OLS regression model with the independent variable of interest being inclement weather days. The model is as follows:

$$\%Scoring3\text{-}5_{District,Year} = \beta_1 SnowDays_{District,Year} + a_{District} + \lambda_{Year} + u_{District,Year}$$

The fixed effect ordinary least squares regression model allows me to best isolate X, or the true impact of inclement weather days on AP exam scores. If the coefficient on inclement weather days is significant at the 5% level after controlling for district and time fixed effects, then I can reject the hypothesis that inclement weather days do not have an effect on AP exam performance.

Panel data is the most effective way to capture variation across districts over time. This is because panel data allows us to control for a plethora of missing or unobservable differences inherent across school districts. While the merits of using an entity and time fixed effects OLS regression model for my research are sound, a potential limitation of this model is that it cannot control for any omitted variable that may vary both across districts and over time; for example, changes in total student enrollment or AP exam participation.

In order to account for the possibility that school districts are concentrated or

spatially clustered, I have mapped all responses in the appendix below, as seen in Figures 1a and 1b. This helps to determine whether my data is geographically representative of the state, as snowfall and Hurricane paths would influence inclement weather days called. These would most likely differ across regions in both Massachusetts and Georgia.

As a supplement to my quantitative analysis of inclement weather and its impact on AP exams, I also conducted interviews as part of a qualitative analysis. These interviews involve superintendents and teachers representing lower tercile school districts, median school districts, and upper tercile school districts selected at random. Ideally, an equal amount of schools from each SES district would be represented in addition to interviews provided by parents from PTA's, but due to the sudden restrictions set by the COVID-19 outbreak, I was unable to achieve this in the given timeframe. By randomly selecting from each SES group, as well as getting interviews from a variety of perspectives, this allows for an all-encompassing examination of the current policy and the groups most affected by it. Within these interviews, I asked questions regarding current inclement weather closure policies and their views on it, recommendations for improvement, and their thoughts on possible alternative learning day replacements for missed school days. Specific interview questions are located in the appendix. With these interviews I hope to add a narrative to the research and contribute personal stories to the field, which currently only considers standardized test scores when it comes to school success.

CHAPTER THREE

Results

In total, I reached out to 154 schools in Georgia, hearing back from 47 total with a response rate of 30.52%. Due to inconsistent AP exam reporting, three school districts were excluded from my observations, bringing the total number of observations to 44 over a five-year period (Figure 1a). The summary statistics for these years can be viewed in Table 1, which includes average inclement weather closures and average percentage of students passing AP exams. In Massachusetts, the response rate was slightly higher, at a rate of 53.82%. I received 148 responses out of a potential 276, only excluding one response due to inconsistent AP reporting, bringing my total number of observations in Massachusetts to 147 school districts reporting over a five-year period (Figure 1b). The summary statistics for these years can be viewed in Table 2.

The appendix displays the results from two separate regressions, including their estimated coefficients, as well as graphs with the plotted regression line. Table 3 depicts the results of the first regression, which runs with a time fixed effects model controlling for school districts, for both Georgia and Massachusetts respectively. In Georgia, with one control, the coefficient on inclement weather days is -0.338, suggesting that for every additional inclement weather day called, the percentage of students receiving a passing score of 3-5 on AP exams decreases by 0.338 percentage points (Figure 2a). However, the is not statistically significant at a significance level of 0.05, making it indistinguishable from a value of 0. In Massachusetts, the coefficient is slightly higher

and statistically significant, at -0.362, indicating that for every additional inclement weather day called, the percentage of passing AP exams decreases by 0.362 percentage points (Figure 3a). Controlling for both district and time fixed effects yields a high adjusted R^2 value, indicating that controlling for unobservable district characteristics explains most of the variation in AP exam scores.

Because inclement weather days are the independent variable of interest, it is unlikely that the statistical significance and low adjusted R^2 values are due to omitted variable bias, as very few variables would affect both the number of inclement weather days called and AP exam scores. Additionally, while the number of inclement weather days called in a district for a given year is theoretically continuous, the variance of the sample's "X" value is small, which could potentially contribute to the impression of the estimated coefficient, β_1 However, it is also unlikely that this imprecision would greatly alter the results.

After exploring my initial research question, I ran a subgroup regression analysis interacting the percentage of economically disadvantaged students with the amount of inclement weather days, which is found in Table 4. In Georgia, I find that in poorer districts with a higher number of economically disadvantaged students, the coefficient is again not statistically significant, with a value of -0.006 (Figure 2b). In Massachusetts in districts with a high percentage of economically disadvantaged students, I found the data to be statistically significant with a coefficient of -0.351 (Figure 3b). This signals that the

more economically disadvantaged a district is, the percentage of students passing decreases by 0.351 percentage points.[4]

Isolating the districts with high levels of disadvantage (those with the highest percentage of economically disadvantaged students) produced varied results by state, seen in Table 5. In Georgia, there was a positive coefficient of 0.302. However, this finding is not statistically significant, making it no different than 0 at any significance level. In Massachusetts, however, more disadvantaged districts see a drop in scores of over 1 percentage point for every inclement weather day called. This holds even when removing Boston Public Schools from the dataset, which has a high level of disadvantage and has the highest amount of inclement weather days for the state. When running this regression for wealthier districts with a low percentage of economic disadvantaged students, their scores remained unaffected.

The results of a test for robustness are found in Table 6. These results certify that my results are still valid despite the cut-off points for low- and high-economically disadvantaged schools, which were the median percentage for both states, respectively. In this test, the variable of economically disadvantaged students is coded as a continuous variable.

These results suggest that while there is a minimal effect at the statewide level in Georgia, the impact felt at all levels in Massachusetts is more significant. This is seen especially in poorer districts, where the decline in academic performance is over 1 percentage point.

[4] When clustering standard error within the district, this finding still holds

Interviews

In total, I interviewed seventeen participants comprised of five teachers and five superintendents from Georgia, and two teachers and five superintendents from Massachusetts. These interviews focused on the procedures for calling inclement weather closures, impact on curriculum, recommendations for future improvement, and thoughts on alternate learning days.

Superintendents

First, looking at procedures for calling off school and the factors involved, student safety was cited by all respondents and was clearly the main concern when making the decision to cancel school. Similar responses to this were the road and sidewalk conditions so students could get to school. Interestingly, only three superintendents, two from high-income districts in Georgia and one from a median-income district in Massachusetts, mentioned familial hardships as a factor considered when closing school. Examples of hardships given include rural homes losing power, reliance on school-provided meals, and the added cost of childcare or missing work for working parents. Additionally, there was a difference in procedures between the states, as Georgia superintendents relied on state-wide agencies for guidance whereas Massachusetts superintendents listed more local agencies for closure advice. Both states had responses indicating the use of inter-district communication as a tool for closure.

When answering how days are made-up, superintendents were in accordance with their state-guidelines, as Massachusetts districts extended the school year for the first five days missed and Georgian districts either did not make-up the days or did so during the school year. One Massachusetts district used Blizzard Bags in addition to extending the school year.

Next, they were asked for their thoughts on alternative learning days, specifically the use of online learning days like the Blizzard Bag program in Massachusetts. All but one high-income districts and low-income districts, and half of the middle-tier districts did not support the program. The primary reason across SES tiers is access to internet or a computer at home for students and teachers. Two of these superintendents also felt that the work done at home was not productive and placed a burden on to teachers. Two of the three districts that did support alternative learning days acknowledged that they had some concerns regarding home internet access, adaptability to students with IEP's, and proper training for teachers. The one district which had been using Blizzard Bags supported the program, listing positive feedback from teachers and parents for the program.

Superintendents were then asked to propose any changes to their current procedure, if any. Half of the superintendents did not propose any change, but the following are suggestions made by the other superintendents: utilizing delayed openings, extending the school day, guaranteeing pay for hourly workers, continuing the Blizzard Bag program, expanding technology use, make-up days during the year, and making the call to close the night before.

Teachers

First, teachers were asked to describe the impact that inclement weather closures had on their curriculum and teaching. All but two teachers described negative impact on their teaching because of these disruptions. The two teachers who felt that their curriculum was not impacted were in untraditional AP courses (AP Art and Design, AP Seminar) which require the production of a final portfolio rather than the traditional sit-down exam format involving multiple choice and written responses in a timed testing environment. Two teachers, both teaching AP Literature and Composition, said that they felt that there was a disruption but that technology has mitigated the severity. They described their main impact to be on in-class discussion and on non-test related curriculum being cut. The three teachers describing the most difficulties with their curriculum due to missed days all teach the most content-specific courses out of those interviewed (AP US History, AP Chemistry, and AP Calculus). Two of these teachers listed cutting curriculum as the most severe issue, having already found difficulties in fitting in all the required learning before AP exams in the spring. One teacher felt that momentum in the classroom was the biggest concern, stating that even when kids came back to school, they would have to review what they learned a few days ago in addition to missing the material from the canceled days.

Dovetailing off of this, teachers were then asked if they perceived any impact on these disruptions on their students AP exam performance. The three teachers in the most content-specific courses believed that exam performance was negatively impacted, two listing lack of preparedness for taking the test. Examples given for this were lack of test-

taking strategies, loss of time management skills, and lack of routine. One AP Literature teacher also felt that their students' performance was impacted by a loss in test-taking strategy.

Next, the teachers were asked for their thoughts on alternate learning days and its impact on their classroom. One teacher was already using Blizzard Bags and two were using online learning in the wake of COVID-19 school closures. All three of those using alternate learning days support them and feel it has helped them transition easily from the classroom, maintain teaching momentum, and communicate with students. One teacher did mention that more training was required for teachers in using online resources before this could be a permanent policy. Those not using alternate learning days echoed the concerns of superintendents, stating lack of internet access at home and extra work placed onto teachers to create online lessons.

Finally, the teachers were prompted to propose any changes to their current inclement weather policy and procedures, if any. Some of the proposed changes are as follows: make-up days during the school year, make-up days within the same marking period, preparing teachers more for transitioning to online learning, more regulations for alternate learning days, and calling off school earlier so that teachers have more time to prepare. It is important to note again that Georgia districts, when choosing to make-up days, do so during the school year, while Massachusetts districts will only do so after five or more days have already been added to the end of the school year.

Discussion

While much research has been done to evaluate the effect of a foreshortened school year on statewide standardized testing, or evaluated absences at the individual level, little evidence has been brought to bear on the impact of an "artificially" shortened preparation period for AP exams on AP exam scores. More importantly, no research has quantified the impact that an unplanned "disruption", such as an inclement weather day, has to school districts. This research supports some of the claims made by this previous research but expands upon the work to dispute many of the results achieved through statewide standardized testing research.

In Georgia, when looking at the effects of inclement weather days statewide, it contradicts the findings in these previous studies, as there is a statistically significant negative relationship between inclement weather days and AP test performance. These results are further confirmed in the analysis of the role that socioeconomic status plays in exam performance and calling inclement weather days. However, these results diverge when controlling for low SES districts, as Georgia sees a negligible impact while Massachusetts sees its most detrimental impact. In Massachusetts specifically, there was a sizable decrease of over 1% passing rate per day in more economically disadvantaged districts, who are also more likely to call an inclement weather day in general as compared to richer districts.

The main finding to run contrary to current research is the statistically significant statewide decline of AP scores in Massachusetts. Though slight, this is the first finding that demonstrates a clear decrease in AP Exam scores as a direct link to inclement

weather closures. With a high R^2 value of 0.897, this demonstrates that the relationship between inclement weather days and AP score performance explains the majority of the variance in these results.

Socioeconomic Impact

The most salient results come from looking at the differences between schools of varying socioeconomic statuses. In Massachusetts, districts with higher percentages of economically disadvantaged students were harmed more by inclement weather closures than their economically stable counterparts. Aside from the literature that already shows poorer districts at a performance disadvantage on standardized testing due to variables like teacher experience, instructional spending, and the general availability of AP exam courses offered, there are additional elements making them especially susceptible to the effects of weather closures. Because these districts are already struggling as is, this can make them more sensitive to the negative impacts of disruptions in their school day.

One main contributing factor to these districts may be the available transportation and infrastructure. In both Georgia and Massachusetts, the districts calling the most inclement weather closures are the main city school districts, Atlanta and Boston, respectively. Both of these districts also considered to have high levels of disadvantage. In either, public transportation is a necessity for most students, and the districts must coordinate buses for thousands of students every day. This requires fully functioning public transportation and clear roads for hundreds of buses on a daily basis. Should the transportation be hazardous anywhere within the city, the district must close, making

them especially susceptible to school closures. In Boston Public Schools specifically, because of the inability to mobilize the large population of students, the district has a policy that does not permit early releases. According to an interview with an administrator within the district, should there be a midday snowstorm, the district is more likely to cancel the school day all together since they cannot send their students home early. It is likely that this policy combined with the issue of transportation is a leading contributor to urban economically disadvantaged districts.

State Comparison

The differences between both state case studies can be associated with a few elements. The first is the preparedness of both states for inclement weather and the types of weather they prepare for. Massachusetts, on average, has 3.325 inclement weather days per year, with almost all of those days being strictly due to snow or ice. These days normally occur sporadically over the course of the school year as the storms come in during the winter, usually only lasting one to two days in length.

Georgia, however, has a slightly different experience with inclement weather days. On average, they receive 1.546 inclement weather days per year, with a mix of hurricane, flooding, snow, and ice days being the cause for the majority. While similar to Massachusetts, they have relatively short, sporadic snow days, but experience these at a lower volume and have the added addition of hurricane-related closures. These closures may be not only be from to the actual storm itself, but also so that the schools in the district can serve as shelters in the wake of the hurricane. This puts some schools districts

out of school for prolonged periods of time, sometimes up to a week or more. Severe hurricanes such as these do not occur every year and do not necessarily impact non-coastal districts, but their occurrence may contribute to the differing results between both states. States with more consistent inclement weather closures, or that generally get less closures on average, like Georgia, may be overall less negatively affected by them than states with a higher volume of inconsistent days off like Massachusetts.

What may be more of an influence on the state variance is the procedure for making up these inclement weather days. Although both states expect to miss a few days a year due to inclement weather and plan accordingly when crafting the school year calendar by building in make-up days, they come at a different time for both states. In Massachusetts, it is mandatory for all districts to make up the missed days, which then are added at the end of the academic calendar, after AP exams have passed. In Georgia, there are two differences in their make-up procedure. First, while they are required to make-up the days, they may obtain a waiver from the state or local school board that permits them to go under the mandatory 180-day year. Most schools do not opt to make up all of their days, especially in years of excessive closure, but when they do, they utilize days that are built into the calendar to do so. All of these dates fall before the AP exam and allow them to simply delay the teaching of the curriculum rather than condensing or cutting any material that cannot be covered before the May exams.

Many of the interviews with teachers support this claim, as almost all of the teachers from Georgia advocated for their use of make-up days during the school year. Unprompted, a handful of Massachusetts teachers suggested changing their make-up

policy from extending the school year to utilizing days built into the school year. Superintendents in Massachusetts echoed these sentiments for change, with some advocating for extending the school day by a few minutes rather than adding on to the end of the school year. One important note was made, however, for those schools utilizing a two-semester block schedule rather than a full-year period schedule. For those using block scheduling, even if days are made up during the school year, they may be added to a marking period in which the class that missed a day is no long in session.

This make-up policy for both states may also explain the divide for rural districts who must provide busing for all students across a larger area of land. Areas like these in Boston and in parts of Georgia are less likely to be completely plowed during a snow storm and therefore more likely to close due to a lack of busing. Rural areas in both states comprise most of the economically disadvantaged districts, in addition to urban districts.

Additionally, the implementation of online learning days as an alternative to in-school make-up days has been a policy in certain districts over the past few years. Primarily in Massachusetts districts, and select districts in Georgia, these online learning days, also known as “Blizzard Bags,” give students a few hours of instructional lessons and activities to complete as a replacement for that day’s missed classes. Though the policy is concluding at the end of the 2019-2020 school year in Massachusetts, some districts have been utilizing this tool for the past few years. Many of these districts do not have a high percentage of economically disadvantaged students because those areas tend to have less access to a computer or internet at home. The wealthier districts utilizing these online learning days may be an additional factor in explaining the decline in poorer

districts, but more importantly explain why wealthier districts as a whole are unaffected by these inclement weather closures.

The teachers interviewed that are currently using some form of online learning reported less disruption to their curriculum and student achievement than prior to their implementation of alternate learning days. This could provide an anecdote for why those using online learning may have had lower disruption effects than those not using it. However, two of those interviewed had only started using online learning during the current school year, so no quantitative data is able to support this.

Policy Proposals

Based on the results of my quantitative analysis above and the suggestions presented by the interviews conducted with superintendents and teachers from across both states, the following policy proposals are suggested for districts:

1. All districts, regardless of state or socioeconomic status, should adjust school calendars so that make-up days are incorporated into the regular school year and not added to the end of the year.
2. Massachusetts state officials should consider creating waivers for schools with over five missed school days due to inclement weather to either: A. meet only the requirements for hours spent of instructional learning, allowing for extended school days or B. go less than the required 180-day instructional period.

3. All districts, especially Massachusetts districts with over 18.9% of the student body qualifying as economically disadvantaged, should allow for early release.
4. All districts should proceed with caution when canceling school due to inclement weather and should utilize other measures, such as delayed starts or early releases, when possible.

Conclusion

From this research, it can be concluded that in Georgia, there is no statistically significant relationship between inclement weather school closures and school district performance on AP exams, while in Massachusetts there is a statistically significant relationship. Furthermore, in Massachusetts, it is confirmed that there is a statistically significant relationship between the socioeconomic status of a school district and their AP exam performance given the number of inclement weather days. Therefore, I find that in Georgia, there is no impact on performance on the AP exam with the number of snow or inclement weather days called, while in Massachusetts there is a negative impact on performance, partially confirming my hypothesis. By extension, it can be concluded that overall student education and academic achievement is hurt by inclement weather closures.

This research not only contributes to the small field of student absences and disruptions to learning, but also may have broader policy implications for school districts in the future. Superintendents in all school districts may now consider adjusting their

procedures due to the negative relationship between inclement weather days and AP exam performance. In districts with a higher population of economically disadvantaged students, specifically in Massachusetts with a drop of over 1% per inclement weather day called, may consider extra caution when calling off school. Policy changes need not only apply to calling the inclement weather days, but also to adjusting the way they make-up these missed days. A transition to online learning may be possible for some wealthier districts, and building in make-up days during the school year is a viable option for all districts.

While my hypothesis has been partially validated, certain limitations of the data collection methodology could be adjusted for future research to expand upon this. To begin, this research only focused on two states. Although Georgia and Massachusetts represent two different environments, expanding the research to include more states out West could further explore the relationships that may vary across these regions. There may even be variation within the state itself, as there was a response rate of less than 50% in Georgia. This low rate may not accurately represent areas of the state that were impacted differently by both snow and hurricanes. As seen in Figure 1a, most of the responses received were from predominantly northern and coastal regions of Georgia. With a higher n value, this may help aid the slight response bias inherent in this study. Future research should attempt to collect the rest of this district level data to gain a more complete understanding of the true effect of inclement weather days on AP exam scores.

Additionally, the research focused on school closures, but did not consider two-hour delays or early dismissals, both of which also impact instructional time. Including

these may have furthered our research by incorporating the total amount of time absent from school due to inclement weather. However, the disruption value evaluated in this study views days where any time is physically spent in a classroom as valuable, mitigating the disruption value.

Another critically important consideration that was not addressed consistently in this research is the timing of inclement weather make-up days. This was asked about certain districts in Georgia that were interviewed, but was not maintained consistently throughout the research process. Almost all school districts in Massachusetts built in five days to the end of their school year to be used in the case of weather emergencies, but it was not tracked how these were made up, or if they were made up at all, should the number of closures exceed the allotted five days. Georgia, as noted, typically builds in these days during the school year before the AP exam, but these days are not consistently used, and in cases where the closures exceed five days, can be made up at the end of the school year. Some school districts, for example, may cancel one day in January due to snow, but then cancel an extended weekend in April to make-up this day. Because this day would fall before the AP exam, if it assumed that all course material was still covered before the exam took place. A suggested method for further research would be to inquire only about inclement weather days that were made up after the exam, as this would isolate the impact of days truly "lost," rather than just reordered. This method would also allow for researchers to investigate the difference, if any, between a disruption in the school day that is then accounted for later versus a disruption that is never made-up.

On a similar note, some schools accounted for lost days by implementing a new program called Alternative Structured Learning Days, or "Blizzard Bags." This practice involves assigning students work that can be completed at home on days when school is not in session due to weather or other emergencies. The assignments completed over the course of the year on these days would replace the make-up days traditionally added to the school calendar in the month of June. My data did not account for this, as only a minimal amount of schools participated in such programs. The effects of these days are unknown due to limited use and recent application, so future research is recommended to investigate these for potential use.

Because AP exams are not free to students like state-administered standardized tests are, a major source of error in our experimental methodology could be the potential for selection bias, which would bias all of the results upward. If the vast majority of students who register for AP exams come from high-income families, then they are likely to already have access to additional outside resources, such as course tutors or additional preparation books, meaning lost class time due to inclement weather days would have a smaller effect on their performance. Another source of error could stem from the fact that some district superintendents decide on school closures conditional upon neighboring school district superintendent's input (Krishnamurthy, 2018). This would mean some observations may not be independent from one another, violating one of the foundational assumptions that allows us to use an OLS regression.

Overall, this study carries on a familiar story. Though, it is not the one presented in the literature on inclement weather closures. Instead, it is the story of inequality in the

American education system. Too often you hear about all of the elements stacked against the poorest of districts to succeed. Public infrastructure, government funding, and the achievement standards set by state standardized tests are leading contributing factors to the setbacks faced by poorer, already disadvantaged school districts. These uncontrollable factors make these districts seem like they are set up to fail and the means to succeed are out of their hands. Adding on the disruptions caused by inclement weather on top of all of this seems like it only furthers the issues at hand; but it doesn't have to.

Using the tools and policy recommendations listed above, districts finally have the ability to take control of an issue. Whether this be an active effort to lessen their calling of inclement weather days or changing the structure of their school calendar to place make-up days during the school year, these measures can come at no cost to the school but, for some, can save them from over a 1% decrease in passing rates per day. This is packaged with a range of benefits for both the school and the student. Schools are posed for better funding or state recognition with either a stable or increasing passing rate for standardized testing, while avoiding a daily 1% decrease in passing rates can mean one or more students passing their exams and getting college credit. Saving money by gaining college credit through the AP exam can be especially important to those living in the low-income districts that are affected the most by school weather closures.

The future can seem dismal for some districts, where their future seems to be in someone else's hands. But in one bright spot in the education system, inclement weather policies can put the powerless back in control.

APPENDIX

Table 1.

Georgia	2014-15	2015-16	2016-17	2017-18	2018-19
Inclement Weather Days	1.083	0.479	1.063	3.813	1.292
	(1.988)	(0.957)	(1.519)	(2.315)	(1.241)
AP Scores (%3-5)	47.6178	47.427	46.529	46.439	46.565
	(15.149)	(15.656)	(16.972)	(17.135)	(18.965)
Observations (n)	44	44	44	44	44
NOTE: Table reports averages with standard deviations in parentheses by year					

Table 2.

Massachusetts	2014-15	2015-16	2016-17	2017-18	2018-19
Inclement Weather Days	4.22	2.06	3.747	5.347	1.253
	(2.377)	(1.218)	(1.63)	(1.876)	(0.932)
AP Scores (%3-5)	65.973	65.528	63.795	63.438	65.851
	(19.301)	(20.238)	(19.85)	(19.915)	(18.879)
Observations (n)	147	147	147	147	147
NOTE: Table reports averages with standard deviations in parentheses by year					

Table 3.

Statewide	Georgia	Massachusetts
Inclement Weather Days	-0.3376098	-0.3620808*
	(0.319821)	(0.1163948)
Observations	220	735
R^2 (adjusted)	0.6981	0.8969
NOTE: Table reports regression coefficients with standard errors clustered by district-years in parentheses. Data are at the district level for years 2014/15-2018/19. * indicates statistically significant at the 0.05 critical value.		

Table 4.

Percentage of Economically Disadvantaged Students	Georgia	Massachusetts
Inclement Weather Days	-0.1477704	-0.3514256
	(0.8723126)	(0.2153433)
% of Economically Disadvantaged Students	0.0310555	-1.034636*
	(1.432399)	(0.0898662)
Interaction Term	-0.0057919	-0.0004479*
	(0.02475)	(0.2153433)
Observations	220	735
R^2 (adjusted)	0.6965	0.8967
NOTE: Table reports regression coefficients with standard errors clustered by district-years in parentheses. Data are at the district level for years 2014/15-2018/19. * indicates statistically significant at the 0.05 critical value.		

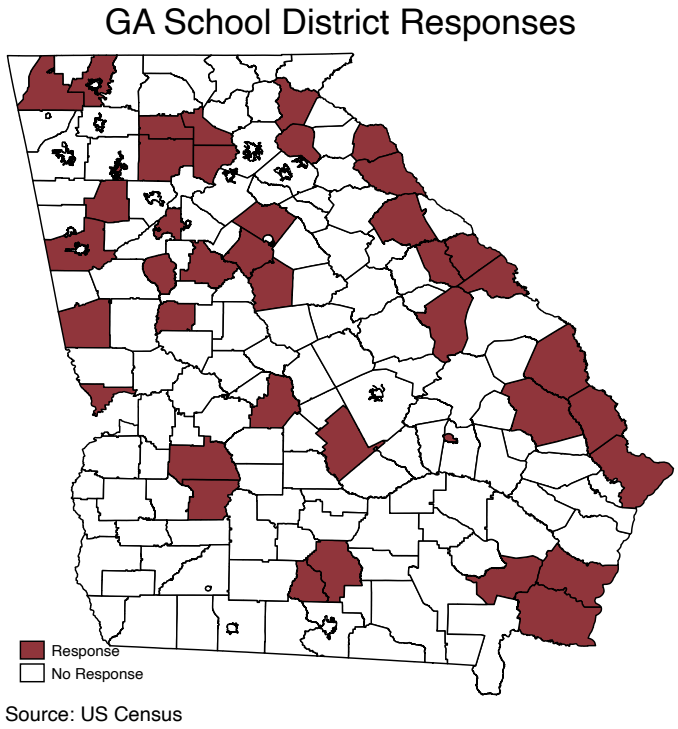
Table 5.

High Percentage of Economically Disadvantaged Students	**Georgia**	**Massachusetts**
Inclement Weather Days	-0.201112	0.2212941
	(0.6777614)	(0.3690703)
High Level of Economic Disadvantage	-15.56705	-19.74813
	(2.470941)	(2.041731)
Interaction Term	0.302363	-1.25179*
	(0.9401981)	(0.5073228)
Observations	220	735
R^2 (adjusted)	0.2047	0.3824
NOTE: Table reports regression coefficients with standard errors clustered by district-years in parentheses. Data are at the district level for years 2014/15-2018/19. * indicates statistically significant at the 0.05 critical value.		

Table 6.

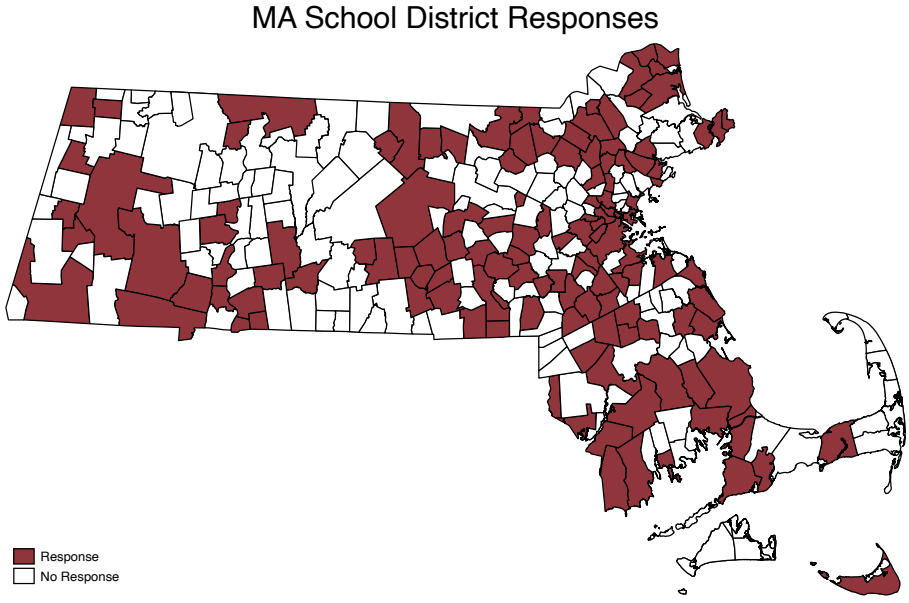
Percentage of Economically Disadvantaged Students (continuous)	**Georgia**	**Massachusetts**
Inclement Weather Days	-0.147704	-0.3514256
	(0.8723126)	(0.2153433)
% of Economically Disadvantaged Students	-0.8510438*	-0.798091*
	(0.1294827)	(0.0640477)
Interaction Variable (weighted continuously)	-0.0057919	-0.0004479*
	(0.02475)	(0.007613)
Observations	220	735
R^2 (adjusted)	0.6965	0.8967
NOTE: Table reports regression coefficients with standard errors clustered by district-years in parentheses. Data are at the district level for years 2014/15-2018/19. * indicates statistically significant at the 0.05 critical value.		

Figure 1a



Source: US Census

Figure 1b



Source: Massachusetts Department of Education

Note: public charter school districts and vocational schools are not noted on the map

Figure 2a

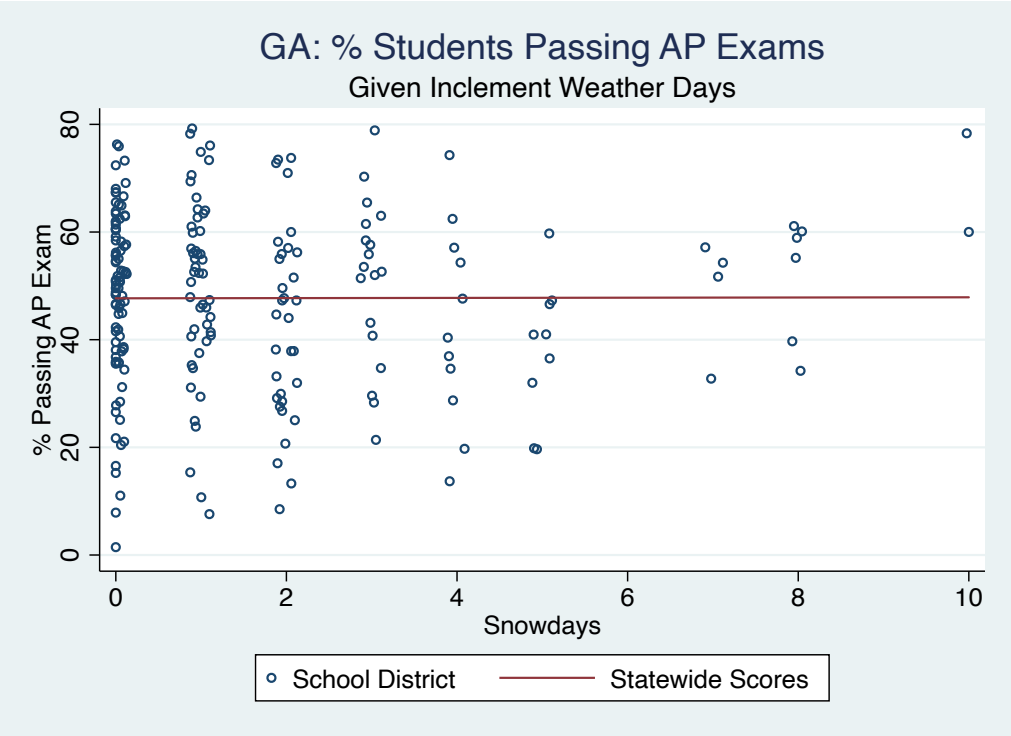


Figure 2b

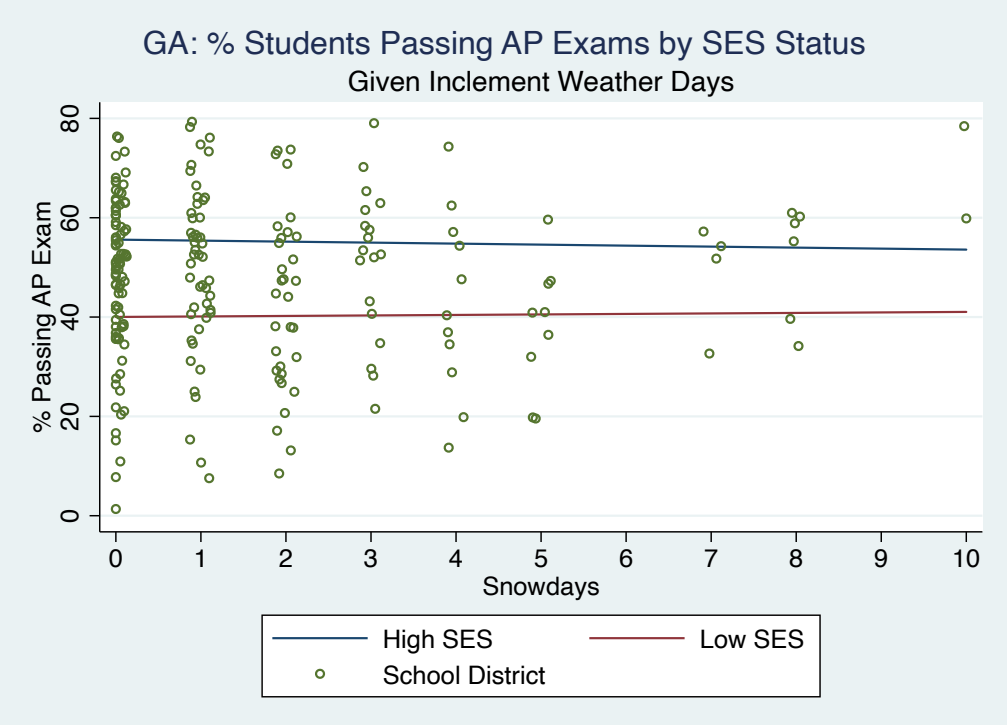


Figure 3a

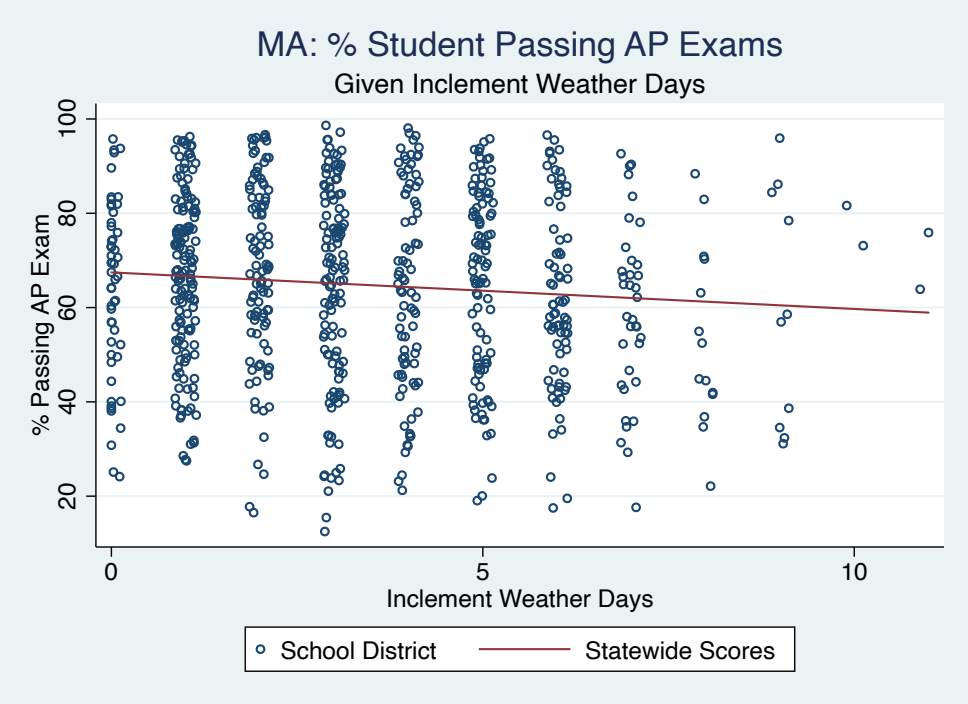
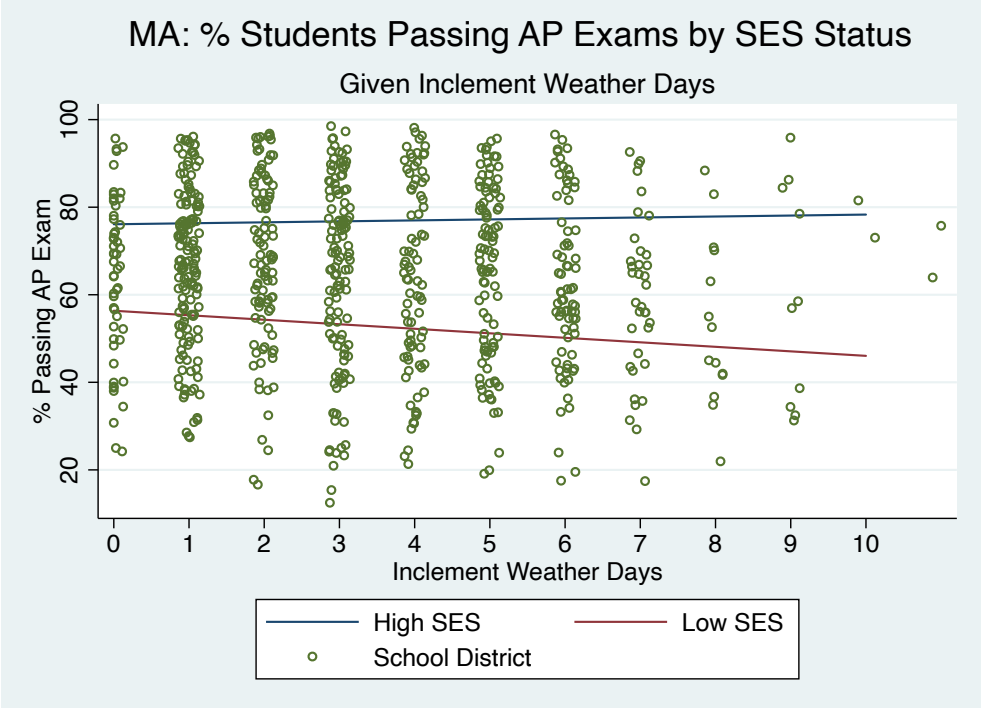


Figure 3b



Superintendent Interview Questions

1. Currently, what is the inclement weather closure policy/procedure for your district? What specific factors are considered when making the call to fully cancel school?

2. How do you currently make up inclement weather days, and when is that implemented?

3. Have you ever considered/used an alternate learning day (online learning, Blizzard Bag, etc.)? Why or why not? If you have used one before, did you find it to help?

4. Are there any aspects of the current closure procedures that you would like to see changed or added to?

Teacher Interview Questions

1. How do inclement weather days (snow days, hurricane days, etc.) impact your teaching/curriculum?

2. How do you make up for these missed days?

3. Do you believe that these missed days have an effect on the AP exam?

4. What changes, if any, would you make to the current inclement weather closing procedures?

5. Do you feel that alternative learning days, such as online lessons, could be valuable?

IRB Determination

Boston University Charles River Campus Institutional Review Board

25 Buick Street
Room 157
Boston, Massachusetts 02215 T 617-358-6115 www.bu.edu/irb

Notification of IRB Determination: Not Human Subjects Research

January 24, 2020

Macella Molenari
Department of Political Science 232 Bay State Road
Boston, MA 02215

Protocol Title: Protocol #: Funding Status: IRB Review:

Dear Ms. Molenari:

Snowed In: The Effects of Inclement Weather Closures on AP Exam Performance 5461X Funded (Weinstein Family Grant)
NHSR

On January 24, 2020, the IRB determined that the above-referenced protocol is not human subjects research as defined by 45 CFR 46.102(e). Per the protocol, the project involves gathering de-identified aggregated data from school districts in Massachusetts and Georgia. The investigator will also conduct interviews with school administrators to obtain information about inclement weather policy.

IRB review of this protocol is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, please submit the ***Clarification Form*** located at *http://www.bu.edu/researchsupport/compliance/human-subjects/*. No changes can be implemented until they have been reviewed by the IRB.

If you have any questions, please contact me at 617-358-6117. Sincerely,

Paul G. Hart
IRB Analyst
Charles River Campus IRB

Cc: Katherine Einstein, PhD

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